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EARLY MAN AND THE ASSOCIATED FAUNAS IN THE OLD WORLD[1]

By Sir ARTHUR SMITH WOODWARD

FORMERLY KEEPER OF THE GEOLOGICAL DEPARTMENT, BRITISH MUSEUM

THE correlation of Pleistocene and later geological formations is always difficult, but the relative ages of the sporadic and isolated deposits which contain the remains and handiwork of fossil man are especially hard to determine. Cave deposits can only be dated by their contained fossils, unless they are clearly associated with some wide-spread incursion of the sea, a pluvial period, or a glacial episode. River terraces, lake terraces, and raised sea beaches can also often be correlated by their relative height above the present level of the water in which they were formed. In neither case, however, is it easy to correlate the past sequence of events revealed by the deposits in one region with those of a distant region. There can be little success unless similar fossiliferous deposits have been traced at intervals through the intervening land.

An interesting illustration of the means of determining the geological age of human remains is afforded by the discovery of the skull of *Eoanthropus dawsoni* in an iron-stained gravel at Piltdown in the Weald of Sussex, England. This gravel occurs in a district where earth movements caused extensive denudation in late Tertiary and Pleistocene times. It consists chiefly of hard waterworn fragments of sandstone and ironstone from the Wealden formation on which it rests; but mixed with the local material there are numerous waterworn flints, which must have been derived from the denudation of the chalk formation which originally overlaid the Wealden district, and still fringes it both to the north and to the south. These flints are well patinated, and many of them exhibit small slightly hollowed flaked surfaces, which suggest that they lay long exposed to the weather—especially to frosts—before they were eventually washed into the gravel by a river.

The Piltdown gravel was certainly deposited by a

[1] Presented before the International Geological Congress, Washington, D. C., July 22 to 29, 1933.

river, and it seems to be the accumulation of a rapid flood or torrent. It varies from two or three to about seven feet in thickness, and when Charles Dawson studied the first section, he published a diagram of it, which showed three distinct layers, possibly of different ages. Subsequent examination of a larger area, however, has shown that the lenticular patches of coarse gravel and finer material are very irregularly arranged; and the larger elongated stones found in the lowest layer often have their longer axis sharply inclined downwards or even vertical, showing that they have been dropped by the sudden check of a very rapid current. The whole deposit therefore may represent only the brief episode of a storm, and the objects found in the different layers may all have been buried at approximately the same time. In any case, the varied staining of the fossils and flints has no special significance, owing to the irregular distribution of the different ferruginous materials in which they were buried. It should also be noted that Dawson altered the color of the first pieces of the human skull which he found by dipping them in bichromate of potash to harden them. The other pieces were hardened merely by a solution of gelatine, which preserved their original color.

None of the existing rivers of the Wealden country have their source in the Chalk, whence, as already mentioned, the flints in the Piltdown gravel were originally derived. At first sight, therefore, it seems as if this gravel dated back to the remote time when the covering of Chalk was much more extensive than it is now, and when the river which flowed over Piltdown actually arose in the Chalk and was obtaining pieces of flint from it. We have already observed, however, that the flints themselves do not appear to have been derived directly from the Chalk by the old Piltdown river, but to have been long exposed to weathering, and even perhaps to have formed part of more ancient gravels, before they were transported to the gravel in which we now find them. We know that such flints are actually derived by one gravel from another, because the comparatively modern deposits of the existing river Ouse, which flows in a valley near Piltdown eighty feet below the terrace or plateau on which the true Piltdown gravel rests, have lately been proved to contain numerous similarly patinated and weathered flints, which must have been obtained by the denudation of the Piltdown plateau itself. In short, as most of the flints are resistant enough to be redeposited in two or three gravels of successive ages, they really afford no clue to the peculiar geographical conditions under which any deposit containing them was formed, and they can not determine its antiquity.

Although, as Dawson showed, the Piltdown gravel extends over an area of several square miles, it is all situated within the basin of one existing river, the Sussex Ouse. The gravel was therefore probably deposited by the direct predecessor of this river, which then flowed on a well-defined plain 80 feet above its present bed and about 120 feet above the present sea-level. Subsequent denudation has left the Piltdown plain as a terrace, and if this can be correlated with any terrace in the valley of the Thames, not far away, where the succession of Pleistocene terraces is clear, its geological age is determinable.

For such correlation, the fossils and implements found at Piltdown need to be considered. They must be carefully scrutinized to decide which of them are contemporaneous with the actual deposition of the gravel, and which may have been derived from some earlier formation in the same way as the pieces of flint already mentioned. The skull of *Eoanthropus* must be of the same age as the gravel in which it was buried, for it is not waterworn, and the brain-case, the delicate fragment of the face, the half of the lower jaw, and the canine tooth were lying separately in four different places, all close together. If these specimens had been transported far, and especially if they had been washed out of an earlier deposit, they would not have been thus associated. Two lower teeth and a piece of the lower jaw of a beaver, found isolated, also seem to be contemporaneous; and they are important, because the peculiar pattern of the teeth differs from the characteristic Pliocene type and agrees with the Pleistocene and later type. Two teeth of the ordinary Pleistocene *Hippopotamus* appear to be in the same state of mineralization, and are likewise not waterworn. Similarly mineralized also are the tooth of a horse (*Equus*), the base of an antler of a red deer (*Cervus elaphus*), and a piece of the metapodial of a small deer which has evidently been broken and scratched by man. Most significant of all the fossils which are obviously contemporaneous with the gravel and the human skull is a piece of bone, 16 inches long, which has been worked by man into the shape of the blade of a cricket bat. Direct comparison shows that this piece was flaked from the middle portion of an elephant's femur which was about 5 feet in length. It therefore represents an elephant larger than the Mammoth of Middle Pleistocene and later date, and doubtless belongs to one of the gigantic Lower Pleistocene elephants, such as *E. meridionalis* or *E. antiquus*. Some broken pieces of the molar of a very primitive elephant, which I have regarded as *Stegodon* and others think may be an early *Elephas*, seem to be more mineralized than the other fossils just enumerated and are perhaps derived from an older formation. Highly mineralized fragments of teeth of *Mastodon* and *Rhinoceros* (probably *R. etruscus*) are exactly like the fossils from the Pliocene Crags of eastern England, and must have been washed out of a local Pliocene deposit which has been

completely destroyed. The fossils clearly contemporaneous with the skull of *Eoanthropus,* therefore, represent a Lower Pleistocene mammalian fauna; while the more highly mineralized fragments have been derived from an earlier formation of Pliocene age.

The flint implements in the Piltdown gravel are also in two states of preservation. Some "eoliths" are so much waterworn and deeply patinated that they must have been washed out of an older gravel. Other "eoliths" have perfectly sharp edges and are less patinated; and there are also a few more elaborately made implements in the same fresh condition. The latter may certainly be regarded as of the same age as *Eoanthropus,* and they are described by Dawson as pre-Chellean. They are all unusual in having been made from large flakes by coarse chipping on the convex face.

If, then, the derived fossils be eliminated, and the other mammalian remains and flint implements be compared with those in the terraces on the sides of the valley of the Thames, the assemblage is found to agree best with that in the "High Terrace" which remains from 80 to 90 feet above the present level of the river. This terrace, which is obviously older than the Middle Terrace where the mammoth, woolly rhinoceros, musk ox, and Arctic lemming occur, is generally admitted to date back to a warm episode at the beginning of the Pleistocene period. The Piltdown gravel, with *Eoanthropus,* 80 feet above the present level of the river Ouse, may thus be ascribed to the same remote date in the history of man.

A review of all the evidence, therefore, shows that the age of the Piltdown gravel with *Eoanthropus* is determined by the associated mammals, the flint implements, and the present height of the terrace on which it is laid.

Until recently, the only other fragments of primitive human skeletons known to rival *Eoanthropus* in antiquity were the lower jaw of *Homo heidelbergensis* from a river deposit at Mauer, near Heidelberg in Germany, and the top of the skull with other remains of *Pithecanthropus erectus,* from a river deposit in Java. The Mauer jaw was dated by its association with mammals which are typically Lower Pleistocene in Western Europe, though they also include at least two species which are survivals from the Upper Pliocene. The age of *Pithecanthropus* was determined both by its association with mammals like those found in the Lower Pleistocene of India, and by its synchronism with certain marine deposits which are known to be post-Pliocene. These two fossils are so different from the jaw and skull of *Eoanthropus* that they prove the human races at the beginning of the Pleistocene period to have been much more varied than they are at the present day. They are rightly referred to three distinct genera, and it is doubtful whether the Mauer jaw really belongs to *Homo.*

Now is added the skull with the lower jaw of *Sinanthropus,* which Dr. Davidson Black has lately described in great detail from a cave deposit near Peking in China. While distinct from each of the other fossils, it is remarkable as combining some of the special features of all three. It agrees with *Eoanthropus* in the fine spongy texture of the skull, which has not yet been observed in any other man or ape; it is also suggestive of our Piltdown fossil in its broad base and peculiarly shaped occiput. In the contour of the top of the head, with the great depressed bony brow-ridges, it is so like the skull of *Pithecanthropus* that some anatomists would refer it to the latter genus. Its lower jaw and teeth are strikingly similar to those of *Homo heidelbergensis. Sinanthropus,* indeed, is a wonderful compendium of the other known early approaches to the modern genus *Homo.*

The geological age of *Sinanthropus* is determined both by stratigraphical observations and by the associated fauna. The deposits in which it occurs are proved by the Chinese geologists to be older than the wide-spread loess of China, which in places contains remains of the woolly rhinoceros (*Rhinoceros tichorhinus*), and in other places the mammoth (*Elephas primigenius*). These, it will be remembered, are two of the characteristic fossils of the Middle Terrace of the Thames, which dates back to the later part of the Pleistocene period. With *Sinanthropus* are found remains of a gigantic beaver, *Trogontherium,* and a rhinoceros very like *Rhinoceros hemitoechus,* which are specially characteristic of the High Terrace of the Thames already mentioned as the probable equivalent of the Piltdown gravel. If, therefore, the widely distributed mammals just enumerated were living at the extreme eastern and western limits of their range in the Old World at one and the same time, as seems almost certain, *Sinanthropus* dates back to the early part of the Pleistocene period and must have been a widely-separated contemporary of *Eoanthropus.*

Having now determined from four sporadic discoveries that primitive types of true men were living with some extinct species and genera of mammals throughout the Old World in the northern hemisphere from east to west at the beginning of the Pleistocene period, the question arises as to where the human race originated. For some time it has seemed probable that the source must have been south-central Asia. Teeth of apes more varied than any found elsewhere have been collected in the Upper Tertiary rocks of India; and it is reasonable to suppose (with the late Dr. Barrell) that when the Himalayan Range arose, the forests in which these apes lived were divided into northern and southern portions. Those apes which were stranded to the north may have been compelled

by inclement conditions to change their habits, become dwellers on the ground, and develop into potential ancestors of man. American and other expeditions have sought hopefully, but hitherto in vain, for some trace of these missing links. I think recent discoveries in Africa suggest that such a search is not likely to meet with success.

During the last few years Dr. L. S. B. Leakey has been exploring Tanganyika Territory in S. E. Africa, and has proved that the jaws and teeth of apes are not uncommon in the Miocene deposits of that region. He has also shown that human remains occur with stone implements in Pleistocene deposits in several localities in the same territory. The succession of types of stone implements is essentially similar to that already observed in Europe; and the fossil mammals of the older Pleistocene deposits, like those in Europe, include a few survivals from the Upper Pliocene fauna. The mammals of the late Pleistocene deposits are little different from those which lived until the dawn of history in East Africa. Most unexpectedly, however, the human remains hitherto found in association with the earlier Pleistocene implements and faunas do not belong to primitive types like those of Europe and Asia, but resemble most closely the corresponding parts of modern man, *Homo sapiens*. One front of a human lower jaw found at Kanam in association with molar teeth of Upper Pliocene species of *Dinotherium* and *Mastodon* and remains of later African types of mammals, exhibits both the characteristic prominent bony chin and the crowded teeth of *Homo sapiens*. The associated stone implements are merely chipped pebbles, which recall the primitive eoliths and other trimmed flints which are older than the simplest Paleolithic implements (Chellean) in western Europe.

So far as can be determined from the fragments available, therefore, typical modern man appeared much earlier in S. E. Africa than in Europe or Asia, though he had not advanced further than his backward northern contemporaries in the art of tool making. It is indeed remarkable to find *Homo sapiens* with stone implements like those which were made by extinct genera of Hominidae in Europe and Asia.

This conclusion suggests to a paleontologist that some part of Africa—perhaps the region of the Rift Valley, which has been subjected to geological convulsions since the Pliocene period—was the original center of humanity. Many years ago, the late Dr. W. D. Matthew pointed out that if each race of animals evolved at a single center, a succession of waves of increasingly differentiated genera must have radiated outwards from that center. The latest and highest types would be found at the actual place of evolution, and they would be surrounded by rings of less advanced types of lower and lower degree until the lowest would occur at the outer limit. Dr. Leakey's discovery may therefore be interpreted as meaning that *Homo sapiens* began at the African center, and that *Eoanthropus, Pithecanthropus* and *Sinanthropus*, which were living at the same time at the extreme edge of Europe and Asia respectively, were the displaced remote offshoots of early stages in evolution at that center.

On the same supposition, the second offshoot was that of Neanderthal (or Mousterian) man (*Homo Neanderthalensis*) who was very widely distributed throughout Europe and part of Asia, and lived in Europe with the woolly rhinoceros and the mammoth. These animals, as already mentioned, are definitely proved to have flourished later than the earliest known races of man at both ends of their range; for they occur in part of the Middle Terrace of the Thames (not in the High Terrace), and in the loess of China which is more recent than the cave deposits containing *Sinanthropus*. As Neanderthal man buried his dead, he is known fortunately by several nearly complete skeletons as well as many fragments. By these comparatively satisfactory specimens he is proved to have varied much in structure, especially in the skull and jaws. Some have therefore supposed that he was evolving into modern man (*Homo sapiens*) and eventually gave rise to this higher and surviving type somewhere in Europe or Asia. As a paleontologist knows, however, variability is a special characteristic of the struggling end of a disappearing race quite as frequently as it is a mark of the beginning of a new race. The variability of Neanderthal man is indeed probably to be regarded as denoting his approaching end.

In this case, the common belief that modern man appeared in Europe as an invader replacing Neanderthal man in the later part of the Pleistocene period seems likely to prove correct. Until after this episode, the three great continents of the Old World were more closely united than they are now. Africa and Europe seem to have been connected by land at least across the present straits of Gibraltar; while Africa and Asia were more accessible to each other when Palestine was the well-watered forested country which recent discoveries of fossil mammals in caves show it to have been.

In conclusion, it must be admitted that no remains of Neanderthal man have hitherto been found in Africa. The remarkable skull from Rhodesia, with enormous bony brow-ridges, can not be referred to this category. Nevertheless, the discoveries of Dr. Leakey in Tanganyika Territory seem to indicate that intensive studies of the Miocene, Pliocene and Pleistocene deposits of the African continent are most likely to enlighten us on human origins.

A HISTORY OF THE NATIONAL RESEARCH COUNCIL 1919—1933

VII. DIVISION OF BIOLOGY AND AGRICULTURE[1]

By Professor FERNANDUS PAYNE
CHAIRMAN

THE Division of Biology and Agriculture was organized on a peace-time basis in 1919, having been preceded by an Agricultural Committee established in 1917. While certain definite objectives were formulated in the beginning, the division has not hesitated to deviate from them or to formulate new ones whenever conditions demanded change.

There was one very definite principle which the division adopted early in its existence from which it has not deviated, and that was that the division should not be an operating organization. By this is meant that projects were to be started, fostered for a time, and then expected to become entirely or for the most part independent. This principle was essential, for if the division had continued to carry all its projects congestion would have resulted and there would have been no opportunity for initiation of new ones.

In any consideration of the work of the division, it should be kept in mind that the several biological societies and, in final analysis, the individual biologists with memberships in these societies, constitute the division. While the work of the division has been carried out by a small group of biologists, they were nothing more than the representatives of the larger group, from whom most of the suggestions for the work of the division have come. The immediate responsibility for the conduct of the affairs of the division has been vested in the chairmanship, which has been filled by the following persons:

1918– —Vernon Kellogg
1919–1921—C. E. McClung
1921–1922—L. R. Jones
1922–1923—F. R. Lillie
1923–1924—R. A. Harper
1924–1925—Maynard M. Metcalf
1925–1926—B. M. Duggar
1926–1927—L. J. Cole
1927–1928—William Crocker
1928–1929—Lorande L. Woodruff
1929–1930—C. E. Allen
1930–1931—W. C. Curtis
1931–1932—Duncan S. Johnson
1932–1933—Fernandus Payne

In the brief presentation which follows only a small part of the work of the division can be given, but this may suffice to give some conception of the many activities in which it has engaged.

The division initiated the National Research Fellowships in the Biological Sciences in 1923, in collaboration with the Division of Anthropology and Psychology. These fellowships are competitive and are awarded by a representative board of fifteen members. During the ten years of its existence a total of 184 appointments (exclusive of anthropology and psychology) have been made. Of these, 47 are serving now. To estimate with any great degree of accuracy the good accomplished by these fellowships is impossible, for many of the values are hidden and they will extend throughout the lifetime of the fellows. It is significant that these fellowships are given for the development of the individual rather than for the completion of a given piece of research, although much valuable research is actually done during their terms of service, as is attested by the number and quality of the papers published.

In addition to the National Research Council Fellowships in Biological Sciences, the division has administered special fellowships. For example: thirteen National Live Stock and Meat Board fellows have been appointed for the investigation of the place of meat in the human diet; eight Sulphur fellows have been appointed for the study of the use of sulphur in the control of plant diseases and insects, and in the improvement of soils for various plant crops; two Seed Germination fellows have been given opportunity to study germination requirements of flower seeds and methods of storage for flower and vegetable seeds. The special Rosenwald Fellowship has also been administered by this division.

By means of grants-in-aid, varying from $70 to $1,500, the division has encouraged 76 different research projects within a four-year period. As in the case of the fellowships, an exact evaluation of the good done is impossible, but the number of mistakes in award has been small, and the quality as well as the volume of the research aided has proven very gratifying.

One of the most comprehensive and significant accomplishments for the aid of research in biology has been the establishment of *Biological Abstracts* in 1926, a task undertaken by the division in cooperation with the Union of American Biological Societies. While perhaps not fully covering all fields at present, the

[1] This is the seventh of a series of ten articles prepared to describe briefly the nature of the activities with which the National Research Council has been engaged during the past fourteen years.

Abstracts present annually a résumé of 30,000 biological contributions.

Before the world war, American biologists were almost wholly dependent upon Germany for biological stains. During the war and immediately afterward, American products were of varying quality. To aid in the improvement and standardization of stains, a joint committee with the Division of Medical Sciences of the Council was first formed; and later an independent commission, which is still functioning, took over the work. This commission has contributed much to strengthening the scientific resources of the United States by encouraging the manufacture in this country of biological stains of high grade and reliable quality. The commission has published a handbook, entitled "Biological Stains" (second edition), and the quarterly *Journal of Stain Technology*.

The division does much of its work through committees, some of which serve for a brief time, while others serve for longer periods. In some cases these committees are formed to initiate and carry through definite pieces of work; in others they may pass from one phase of the subject to another, thus acting as permanent committees. As an example of the first type, the committee on the Marine Biological Laboratory may be mentioned. This committee was formed for the specific purpose of helping to secure funds to place the laboratory on a better and more secure basis. The laboratory has now adequate accommodations for a large number of biologists who may wish to utilize its facilities, and the library is rapidly being developed into one of the best in the country. The results on biological research are incalculable.

The Committee on Effects of Radiation on Living Organisms has succeeded in obtaining a considerable sum of money for a study of the effects of radiation on living organisms. By means of grants to individual investigators, more than 48 researches in this field have been aided, and the committee is still active. Grants have also been made to the Biological Laboratories at Woods Hole and at Cold Spring Harbor. To date, 61 papers have been published as a direct result of these grants. Since the committee has been in operation only four years, the number of papers gives an inadequate conception of the amount of work done. Results will continue to appear over a period of several years. In addition to administering the program of special grants, the committee is making a comprehensive survey of the problems of research in the fields of radiation of light, x-rays and radium emanations, both on animal and plant tissues. This survey is considering especially the application of research in radiation to problems of genetics, general physiology, embryology, growth and development, photosynthesis, photo-periodism and motor response.

From its beginning, the division has been interested in research in tropical America, particularly the agricultural and phytopathological phases, and several committees have worked toward these ends. The Tropical Plant Research Foundation was an outgrowth of the Committee on Phytopathology in the Tropics, and it was formed to promote, in general, research on the plants and crops in the tropics. The principal research project of the foundation was an investigation of sugar cane production problems in Cuba, in which work it centered its attention mainly on four outstanding problems, namely, the mosaic disease of sugar cane, the root diseases of cane, the moth stalk borer of cane, and cane varieties. An experiment station for sugar cane was established in Cuba and branch stations were maintained for variety testing and propagation. The foundation also conducted studies upon the forestry problems of Cuba and tropical America, and the chicle investigations of Central America. In addition an office was maintained in Washington for general information on problems of tropical America.

The Institute for Research in Tropical America, established by the National Research Council, has sponsored the establishment of the Barro Colorado Island Laboratory in the Canal Zone. The laboratory is a tropical station well located with respect to accessibility and opportunities for biological research in the tropics, and with adequate facilities for a limited number of workers. It has become a station of importance for tropical research.

The Committee on Forestry has been actively interested in methods for the reforestation of cut-over lands, improved methods of silviculture, and statistics on silviculture and forest resources of the world. As a result of their investigations, two volumes have been published on "The Forest Resources of the World" and another on the "Volume, Yield, and Stand Tables for Second Growth Southern Pines." A bibliography of North American forestry is now ready for publication.

An example of a direct cooperation with industry is found in the Advisory Committee of the American Institute of Baking, which helped in the selection and solution of some of the scientific problems which confronted the baking industry.

If space permitted, it would be desirable to discuss in detail the work of the Committee on Food and Nutrition organized in 1919 and engaged in the study of the relationship between fertility and nutrition, growth curves in animals, meat and milk in the food supply, and many other important topics; the work of the Committee on Atmosphere and Man, concerning the effects of atmospheric conditions upon mortality, and particularly upon influenza mortality, and the effects of factory conditions upon mortality; the

activities of the joint Committee of this Division with the Division of Medical Sciences of the Council on Microbiology of the Soil established in 1929, which has for one of its several purposes the study of the fate of certain pathogenic organisms in the soil, particularly the tubercle bacillus; the Committee on Infectious Abortion organized in 1922 and operating jointly with the Division of Medical Sciences in the study of the diagnosis, immunology and chemistry of the organisms of this pernicious disease, and the classification of a collection of 700 strains; and the Committee on Pharmacognosy and Pharmaceutical Botany, which has been preparing a map of the geographical distribution of drug plants in the United States. The Committees on Human Heredity, on Animal Breeding, on Family Records, on Tropical Research, on Marine Piling Investigations, on Forestry, on Botanical Nomenclature, on Agriculture, can only be mentioned. A new Committee on Wild Life was organized in 1931 for the purpose of investigating problems relating to the conservation of wild life. It has been proposed to make surveys of wild life, to establish fellowships and grants-in-aid of wild life research, and to prepare a report on the wild life situation.

In many cases where financial help was not needed, or where it could not be given, the division and the Council have given their endorsement, thus lending their moral support. Examples of this sort are found in the experimental program of the Brooklyn Botanic Garden, and the Biological Laboratories at Cold Spring Harbor, Mount Desert Island, (Gothic, Colorado) and the Glacier Bay National Park. Many other projects have been aided in their initial stages by means of small grants.

The problems of research publications in biology are not for a single editor to solve. Instead, they need the concerted efforts of all editors, and even of the individual biologists who write the papers. The problems of aquiculture are many and complex, involving the fields of zoology, botany, chemistry, physics and geology. Hence, for their solution they need the cooperative efforts of men from these different fields of interest. In these and other cases, groups of workers with similar or kindred interests may meet to plan and outline specific projects, and to consider ways and means of carrying out a given piece of work. They may also meet to discuss, clarify and focus attention upon the more fundamental problems in a given field. The division has fostered many such conferences, and much of its work has been initiated in this way.

Finally, it may be said that now, more than ever, the division needs the active support and cooperation of every biologist, if it is to continue to carry on its work effectively; and it is hoped that this brief sketch will aid them in visualizing more fully its potentialities.

SCIENTIFIC EVENTS

THE AMERICAN STANDARDS ASSOCIATION AND THE BUREAU OF STANDARDS

THE following activities of the National Bureau of Standards are to be transferred to the American Standards Association, a federation of thirty-seven national technical societies, trade associations and governmental bodies, with headquarters in the Engineering Societies Building, New York City, as the result of an arrangement worked out between Secretary of Commerce Daniel C. Roper and President Howard Coonley, of the American Standards Association:

Division of Trade Standards
Division of Specifications
Division of Simplified Practise
Building Code and Plumbing Code Sections of the Building and Housing Division
Safety Code Section

In making arrangements for the transfer, Secretary Roper wrote to Mr. Coonley in part as follows:

The Bureau of Standards is discontinuing most of the work which it has been carrying on in the field of simplification, commercial standards, safety codes and building codes. This step, undertaken in the belief that these functions should be in the hands of industry and consumer groups, is being carried out as a part of the government economy program.

I am pleased that we shall be able to count on the American Standards Association to carry on the essentials of this work, which, as a result of our discussions, I now understand the association will be prepared to do. Its experience and standing as the national clearing house for industrial standardization, and the cooperative methods which it has developed during the past fifteen years fit it for the increased responsibilities and the enlarged program entailed.

Mr. Coonley in reply writes:

You are probably aware that the American Standards Association, as a federation of trade associations, technical societies and governmental departments, depends for financial support on the voluntary membership dues of associations and companies. Our most pressing immediate task, if we are to continue the new work effectively, is to obtain a substantial increase in our financial support. I can assure you that every effort will be made to accomplish this end. And since the department's

action is largely in recognition of the desire of industry to carry on standardization through its own cooperative organization, I have no doubts concerning the ultimate success of our efforts.

THE NEW HALL OF PHYSICS AT WASHINGTON UNIVERSITY

THE Board of Directors of Washington University has announced an anonymous gift amounting approximately to $700,000 to be used for the construction and maintenance of a new physics laboratory and for the support of teaching and research in physics. Of this sum approximately $250,000 will be used for construction of the new building, $100,000 will be used as an endowment for its maintenance (heating, lighting, janitor service, etc.) and $350,000 as an endowment, the income from which will be used for the support of the department. Contracts for the building have been let and construction is to start immediately. It is planned to have it ready for occupancy by next summer.

The plans have been worked out with great care by the architects, Jamieson and Spearl, St. Louis, with the cooperation of the staff of the physics department, which is headed by Professor A. L. Hughes. They call for a 2-story building 175 feet long, the rear wing being 52 feet wide and the front portion 105 feet wide. It will be the first unit of a proposed applied science group which will eventually form an imposing quadrangle on the north side of the campus. The laboratory is especially designed to provide adequate facilities for carrying on the research of the department. In addition to the basement, given over entirely to research, there will be a sub-basement, 53 x 66 feet, which will be air-conditioned, and designed for experiments requiring temperature regulation or freedom from vibration. Provision is made so that a large portion of the roof can be used for an out-of-door laboratory.

The plans for the wiring and plumbing call for an unusually elaborate layout for a building of this size. Over eight miles of copper wire, in addition to that used for ordinary lighting circuits, will be used to furnish each research room, lecture room and laboratory with an adequate power supply for all experimental and demonstration purposes. A specially designed system of local wiring in each individual room will make it possible for each piece of apparatus to be placed near the power outlets. Water, gas, air and vacuum lines will also have several outlets in each room. Adjacent to the elevator shaft there will be an open experimental shaft, with balconies at each floor, extending from the sub-basement to the top of the tower room, a total height of about 60 feet.

Special precautions have been taken to keep the building as free as possible of mechanical vibrations. All heavy machinery in the shops will be on concrete floors which are insulated from the rest of the building by 3 inches of cork. A special girder construction will add to the rigidity of the structure and reduce wind sway and other vibration.

The increased facilities afforded by the new building and its accompanying endowment will allow a considerable expansion of work. The research of the department first attained national recognition under the leadership of Professor A. H. Compton, who was department head from 1920 to 1923, and it was in this period that the Compton effect was discovered. Research activities have continued to expand in various fields under the direction of Professor Hughes since 1923. The present gift to the university has been made by the donor in recognition of the place of distinction which the present staff of the department holds in the scientific world and of the importance to the world of continued research in the field of physics.

A list of the present permanent members of the department and the fields of research in which they are active follows:

A. L. Hughes, D.Sc., Wayman Crow professor of physics and head of the department. Electron scattering, photoelectricity, spectroscopy.

G. E. M. Jauncey, D.Sc., professor of physics. Absorption and scattering of x-rays; the Compton effect.

C. F. Hagenow, Ph.D., associate professor of physics. Spectroscopy.

L. A. DuBridge, Ph.D., associate professor of physics. Photoelectricity; direct current amplifiers.

J. A. Van den Akker, Ph.D., instructor in physics. Photoelectric effect of x-rays.

RETIREMENT OF INVESTIGATORS OF THE U. S. GEOLOGICAL SURVEY

VERNON BAILEY and T. S. Palmer, of the Bureau of Biological Survey, U. S. Department of Agriculture, retired on July 31, Mr. Bailey after forty-six years' service and Dr. Palmer after forty-four years.

Vernon Bailey, chief field naturalist of the bureau, has achieved wide recognition for his studies of the geographic distribution of mammals, birds and plants. His work in building up the collections and files of information of the survey is especially noteworthy. Practically every season since Mr. Bailey's first service has been marked by his field work in some part of the United States, and wild-life studies have taken him to every state of the Union and to Mexico and Canada. He has conducted biological surveys of Texas, New Mexico, North Dakota and Oregon, and has published reports on the mammals of Glacier National Park, on the animal life of the Carlsbad Caverns and on that of Yellowstone National Park. On the pocket gophers and on the

ground squirrels of the Mississippi Valley he has prepared special publications based on his field work, and has revised the classification of rodents in these and other genera. Only recently the bureau added to the list of publications written by Mr. Bailey the "Mammals of New Mexico," in its North American Fauna Series. At present, as joint author with Dr. Florence Merriam Bailey, his wife, he has in press a work on the wild life of the Mammoth Cave region of Kentucky. His work on Oregon has not yet been published. Mr. Bailey has also been widely recognized for his efforts in behalf of the humane treatment of animals, especially because of the traps he has invented to capture them alive and unhurt.

A native of Michigan, Mr. Bailey was first employed in the Department of Agriculture as a special field agent in 1887, when he was twenty-four years old and living in Minnesota. In 1890 he gained his present title of chief field naturalist. From 1906 to 1913 he was in charge of what is now the division of biological investigations of the survey.

Mr. Bailey is president of the American Society of Mammalogists and a former president of the Biological Society of Washington.

Dr. Theodore Sherman Palmer is known as a zoological historian and biographer, as an authority on the nomenclature of mammals and also for his activities in game protection. He was chairman of the committee that prepared regulations under the migratory-bird law of 1913, and he also prepared the preliminary draft of the Migratory Bird Treaty of 1916 between the United States and Great Britain.

He was instrumental in initiating legislation governing importations of game and other wild animals and birds from foreign countries and has cooperated with officials of the Customs Service in drafting regulations. He originated the present system of Federal publication of the game laws and open-season posters and of directories of game-protective officials and organizations, and the numerous official publications of the Biological Survey on trends in game conservation and in legislation for the protection of wild life, some of which have been translated and published abroad. Monumental among his published writings is his "Index Generum Mammalium," issued by the Biological Survey in 1904 as North American Fauna No. 23. He is now completing a supplement to it.

Dr. Palmer, a native of California, was graduated from the University of California in 1888 and came to the Department of Agriculture the following year, at the age of 21. In 1895 he completed medical studies and was granted the M.D. degree by Georgetown University. He early engaged in field studies and has visited most parts of the United States, and for five months in 1891, as first assistant ornithologist, he was acting in charge of the Death Valley Expedition. He was assistant chief of the Biological Survey from 1896 to 1902, and from 1910 to 1914, and acted as chief over extended periods, including the time when the chief, Dr. C. Hart Merriam, was in Alaska as a member of the Bering Sea Commission. From 1900 to 1916, Dr. Palmer was in charge of the bureau's division of game preservation, and since the passage of the Lacey Act in 1900 he has been in charge of the regulation of the importation of foreign birds and mammals.

OBITUARY

FRANK WILLIAM PEEK, JR., chief engineer of the Pittsfield works of the General Electric Company, was killed at Gaspé, Quebec, on July 27, when the automobile he was driving was struck by the locomotive of a Canadian Railway train at a grade-crossing. Mr. Peek was in his fifty-second year.

DR. EDWARD CAMERON KIRK, seventy-seven, professor emeritus of the School of Dentistry of the University of Pennsylvania, died on July 21.

THE death is announced of John Eliot Thayer, member of the Museum of Comparative Zoology of Harvard University. Mr. Thayer built a museum in Lancaster, Massachusetts, for the public with one of the best collections of birds in North America.

SCIENTIFIC NOTES AND NEWS

WITHIN the last few months Professor John J. Abel, director of the Laboratory of Endocrine Research at the Johns Hopkins University, has been made an honorary member of the American Association of Physicians and of the Pharmacological and Physiological Societies of Great Britain. He has also been made an honorary fellow of the Royal Society of Edinburgh.

PROFESSOR EDWIN GRANT CONKLIN, of Princeton University, has been elected an honorary fellow of the Royal Society of Edinburgh.

DR. THOMAS B. NOLAN, geologist of the U. S. Geological Survey, has been awarded the Spendiaroff Prize of the International Geological Congress in recognition of his studies of the complex earth structure of western mining districts of the United States.

THE daily press reports that a bill now before the House of Commons will enable Professor Albert Einstein to acquire British citizenship.

SIR COLIN MACKENZIE, director of the Australian Institute of Anatomy, has been elected president of the Royal Society of Australia. The society has its

headquarters in the national capital and branches in the various states.

A CORRESPONDENT writes: "After many years of distinguished service, Geheimrat Professor Otto Appel has resigned the directorship of the 'Reichs' Biological Institute of Agriculture and Forestry, Berlin-Dahlem, Germany. Dr. Appel continued in office for a time after reaching the statutory age limit, but has now finally severed his connection with the institution, which owes so much to his indefatigable activities and ability for organization. On his retirement, Dr. Appel, who has made many friends on this Continent, both during his frequent visits here and by his unfailing courtesy and helpful advice to colleagues visiting him in Dahlem, was signally honored by President von Hindenburg, who, in a personal letter of thanks to Dr. Appel, wrote: 'I am highly grateful to you for your loyal service to your country and especially appreciative of your life's work devoted to the welfare of German agriculture. The Biological Reichsanstalt owes to you its present organization, which has brought the highest praise from home and abroad, to the entire German phytopathological service.' Dr. Appel will continue his academic teaching in connection with the Agricultural Academy at Dahlem."

DR. HERBERT OSBORN, of the Ohio State University, has been made emeritus professor in zoology and entomology and retires from active teaching in conformity with provisions of the state teachers retirement system. He will continue his research work with facilities of the department and as director of the Ohio Biological Survey.

AT Oberlin College, the retirement is announced of Professor Frederick Orville Grover, head of the department of botany. Professor Grover became associate professor at Oberlin in 1898 and was appointed professor in 1900. The retirement is also announced of Dr. S. F. MacLennan, professor of philosophy and comparative religion, who joined the faculty thirty-six years ago.

FOLLOWING the election of Dr. Arthur H. Daniels, who had been dean of the Graduate School and acting dean of the College of Liberal Arts, as acting president of the University of Illinois, Professor R. D. Carmichael, head of the department of mathematics, has been made acting dean of the Graduate School and Professor M. T. McClure, head of the department of philosophy, acting dean of the College of Liberal Arts. To fill a vacancy caused by the retirement of Dean M. S. Ketchum, of the College of Engineering, Professor Arthur Cutts Willard, head of the department of mechanical engineering, has been appointed acting dean. Dr. Ketchum will retain a research professorship in civil engineering.

H. C. GEORGE, who took charge of the newly established School of Petroleum Engineering at the University of Oklahoma in 1924 and who has been director of the school since that time, has resigned to become head of the department of oil and gas production at the University of Pittsburgh.

DR. ROBERT ALLAN MOORE, instructor in pathology in the School of Medicine of Western Reserve University and assistant pathologist of the Lakeside Hospital, Cleveland, has been appointed assistant professor of pathology in the Cornell University College of Medicine, New York City.

DR. KURT WACHHOLDER, of Breslau, has been appointed professor of physiology at Rostock, Dr. Oskar Seifried professor of pathology at Munich and Dr. Eduard Pernkopf professor of anatomy at Vienna.

THE officers, executive committee and members of the Division of Geology and Geography, National Research Council, for the year 1933–1934 are as follows: *Chairman,* W. H. Twenhofel; *Vice-chairman,* W. L. G. Joerg; *Executive Committee,* W. H. Twenhofel, W. L. G. Joerg, James Gilluly, R. S. Knappen and Morris M. Leighton; *Representatives of Societies,* E. H. Sellards and E. C. Case, Geological Society of America; W. F. Foshag, Mineralogical Society of America; August F. Foerste, Paleontological Society; K. C. McMurry and Nevin M. Fenneman, Association of American Geographers; W. L. G. Joerg, American Geographical Society; James Gilluly, Society of Economic Geologists; R. S. Knappen, the American Association of Petroleum Geologists; *Members at large,* W. H. Twenhofel, Mark Jefferson and Morris M. Leighton.

DR. HENRY CHARLES TAYLOR, who was until 1931 research professor of agricultural economics at the University of Vermont, has been designated by President Roosevelt to represent the United States on the permanent committee of the International Institute of Agriculture at Rome. His appointment revives an office which has remained unfilled for several years.

NELSON C. BROWN, professor at the State College of Forestry at Syracuse, New York, is one of those named as special inspectors during July and August for the forestry camps of the Civilian Conservation Corps.

JAMES H. CISSEL, professor of structural engineering in the College of Engineering of the University of Michigan, has been named bridge designer in the Department of the State Highway Commissioner. He took office on July 1. Professor Cissel has been granted leave of absence from the university.

Nature reports that Professor Julian S. Huxley has accepted the invitation of Messrs. Thornton Butterworth, Ltd., to become science editor of the "Home University Library," in succession to the late Sir J. Arthur Thomson. The "Library," founded in 1911, and added to each year, now consists of more than 160 volumes covering the chief subjects in history and geography, literature and art, science and social science, philosophy and religion. Professor Huxley joins the Right Honorable H. A. L. Fisher and Professor Gilbert Murray on the editorial side.

DR. ERMA A. SMITH, associate professor of physiology at the Iowa State College, has been allotted a grant by the American Medical Association to be used in a study of the effects of sublethal percentages of illuminating gas.

DR. AMADEUS W. GRABAU, chief paleontologist of the Chinese Geological Survey, professor of paleontology at Columbia University for eighteen years prior to his going to the National University of Peiping, China, is visiting New York. He is accompanied by Dr. V. K. Ting, the assistant director of the Geological Survey of China. Dr. Grabau expects to return to China in September.

DR. F. B. SUMNER, professor of biology at the Scripps Institution of Oceanography, University of California, has been granted leave of absence until December 31, which he will spend in study and writing in the San Felipe Valley, Tucson, and at the University of California.

AT the recent Chicago meeting of the American Society for Testing Materials, Herbert J. Gough, superintendent of the engineering division of the British National Physical Laboratory, delivered the 1933 Marburg Lecture.

AT the closing session on July 29 the International Geological Congress approved the action of the council to hold the next International Geological Congress in Soviet Russia. Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, president of the congress, read before the closing session a letter from President Roosevelt, greeting the congress officially on behalf of the United States and expressing his regret at his inability, "due to the extreme pressure of public duties," to convey his greetings personally. He added that it was "a source of great pride to the people of this country" that the delegates should have chosen the United States for their meeting place.

DR. ROBERT E. WILSON, vice-president of the Standard Oil Company of Indiana, has been appointed general chairman of a committee to make plans for the eighty-sixth meeting of the American Chemical Society in Chicago from September 10 to 15. Dr. Wilson is in charge of the company's research and development activity, and is a director-at-large of the society. The meeting will trace a century of progress in chemistry, and is expected to attract more than 3,000 scientific men from all over the world. Among the speakers will be distinguished chemists of Great Britain and the Continent. Development of the chemistry of petroleum and of the petroleum industry will feature the discussions. The Division of Petroleum Chemistry, of which F. W. Sullivan, of the Standard Oil Company of Indiana, is chairman, will hold five sessions, three of which will be given over to a symposium on "Hydrocarbon Decomposition," under the chairmanship of E. M. Clark. The Division of Gas and Fuel Chemistry, of which Professor A. W. Gauger, of the Pennsylvania State College, is chairman, and the Division of Organic Chemistry, headed by Professor C. S. Marvel, of the University of Illinois, will participate in the symposium. Leading oil chemists from the industry and the research laboratories of the nation will present papers.

A QUARTER of a century of teaching and research in natural science under natural conditions will be marked when the University of Michigan Biological Station at Douglas Lake holds its annual visitor's day from 2 to 5 o'clock on Sunday, August 6. In recent years visitor's day has become an event for residents and tourists in the Douglas Lake area. In addition to an invitation to the general public, visitor's day this year will feature a special program for Michigan alumni, with Northern Michigan Alumni Clubs participating. Professor George R. LaRue is director of the station. Beginning in 1909 with a log cabin laboratory and a few tent homes, the station has developed into the largest fresh-water center in the world for study of plant and animal life under natural conditions. There are now one hundred and thirty buildings, housing students and investigators from all parts of the country and twenty-five to thirty articles are published each year, describing scientific investigations, and circulated to all parts of the world. Although primarily a teaching branch of the university, much independent research is also carried on in Douglas Lake and the surrounding country. Often this is of economic importance, such as the studies of parasitic worms which nineteen persons are carrying on this year. The George Washington Memorial Forest, established by the station with the cooperation of Cheboygan County schools, and a planting of 600,000 trees in a reforestation project, are other activities of the station. On August 6 all the exhibits of the station will be thrown open and faculty and students will serve as guides to visitors.

BY the will of J. DeW. Sterry public bequests are made amounting to $103,000. These include $11,000 to Princeton University and $10,000 to the American Museum of Natural History.

THE New Hampshire Forestry Commission has recently received through a bequest of Miss Caroline A. Fox, of Hillsboro, New Hampshire, a trust fund of approximately $200,000, the income from which is to be devoted to forest research and demonstration at Hillsboro and elsewhere in New Hampshire. Research at Hillsboro will be centered on the Caroline A. Fox Reservation, which was donated to the state by Miss Fox. Dr. Henry I. Baldwin, formerly research forester for the Brown Company, Berlin, New Hampshire, has been appointed resident forester. Dr. Baldwin has been a member of the faculty of the Pennsylvania State College during the past year, and takes up his new work on August 1.

A RESOLUTION was recently passed by the Court of the University of London conveying cordial thanks to the Rockefeller Foundation for a further generous donation to University College of £4,000 for the reconstruction and equipment of additional laboratories for the department of physiology at the college, to accommodate an expansion of the work in biophysics.

BY action of the Board of Regents of the University of Texas, the old Engineering Building, vacated by the College of Engineering in favor of the new $400,000 structure which adjoins the power plant, has been officially named "The Journalism Building." It will house the department of journalism, the student publications and the university office of publicity in the autumn. The building was erected in 1904.

THE National Geographic Society has leased space on the fifty-fourth floor of the RCA Building in Rockefeller Center. Early next month it will move from 350 Madison Avenue to the new quarters, which will be approximately twice as large as the space now occupied.

THE Ohio Academy of Science assembled for the annual field excursion under the direction of Dr. Karl Ver Steeg, chairman of the Section of Geology, on May 27 and 28, at Millersburg, Ohio. The trip was devoted to a field study of the glacial features, stratigraphy and physiography of Holmes County. The area examined in the vicinity of Millersburg and Loudonville afforded an excellent opportunity to see the glacial boundaries of the Illinoian and Wisconsin ice-sheets. The problem of glacial stagnation in the valleys in Holmes County and drainage changes, resulting from glaciation, are of considerable interest. The first day the area west of Killbuck Creek, in the vicinity of Millersburg, was examined. Here the results of glacier stagnation, moraines, kame terraces, varved clays, outwash deposits, drainage changes, the contact between the Waverly and Pennsylvanian series and the Harrisburg erosion surface were studied. On the next day the region northwest of Millersburg and in the vicinity of Loudonville was inspected. The evidences of glacier stagnation in the broad valley in the vicinity of Loudonville were investigated. George W. White, professor of geology at the New Hampshire University, who has made an intensive study of the region for a number of years, was the guide. After dinner in the evening the party gathered for a discussion. About thirty-five members, mainly from the colleges and universities in the state, attended the excursion.

DISCUSSION

NOTES ON THE FALL OF COLUMNS DURING THE LONG BEACH EARTHQUAKE

THE use of overthrown columns for determining the position of seismic focus, developed by Robert Mallet in his study of the Neapolitan earthquake of 1857 and later used by Omori[1] and others, has been invoked by the writer in a study of the recent earthquake in Long Beach, California. It is interesting to compare the results obtained by this older method with those of the highly organized system of seismological stations maintained by the California Institute of Technology and the Carnegie Institution of Washington throughout southern California.

The earthquake occurred at approximately 5:55 P. M., Pacific Standard Time, on March 10, 1933, the greatest amount of damage being done in the cities of Long Beach and Compton, although other neighboring towns had many buildings destroyed, and a large part of southern California was distinctly shaken. The writer visited the damaged area shortly after the shock and at that time gathered the data here set forth. He wishes to acknowledge the assistance rendered by two of his students, Mr. Duncan A. McNaughton and Mr. Diamond Kimm.

The method of procedure was simple. Since it was desired to observe the direction of propagation of the earthquake waves as indicated by their effect on free-falling columns, work was confined to cemeteries. Fourteen cemeteries in the general vicinity were visited by the writer or his assistants, but in most of these either there were no monuments at all or none had been thrown down. In five, however, data were collected.

[1] C. Davison, "A Manual of Seismology," pp. 51–52, 119–121. Cambridge University Press, 1921.

Certain precautions were taken in order to keep down the possible error. Stones whose shapes might cause them to fall in some particular direction were disregarded, and those only used that were of square or round base. Furthermore, those columns whose bases were tilted to the extent of possibly giving direction to the fall were eliminated. The writer feels, therefore, that the results herein given are comparatively accurate.

The cemeteries in which the data were obtained are the following: (1) Sunnyside, on Willow Street between California and Orange Avenues, Long Beach; (2) Artesia, just to the northwest of the town of Artesia; (3) Old Downey, south of Downey; (4) Woodlawn, just south and west of Compton, and (5) Wilmington. In the last named there were but two monuments that might be included in the specified types and these fell at right angles to each other, thus vitiating any inferences that might be based on their direction of fall.

Observations on thirteen monuments in the Sunnyside Cemetery showed ten of them to have fallen within the fifteen degree angle between N 5 W–S 5 E and N 20 W–S 20 E. Of twenty-four columns in the Artesia Cemetery twelve were between N 60 W–S 60 E and N 85 W–S 85 E. Six of the seven stones in Old Downey Cemetery lay between N 85 W–S 85 E and S 63 W–N 63 E, and four of the six in Woodlawn fell either east or west. Plotting all the observations made on an accurate map of the region and projecting the lines in both directions, since it is obvious that the columns may have fallen either toward or away from the focus, the results shown in Fig. 1 are obtained.

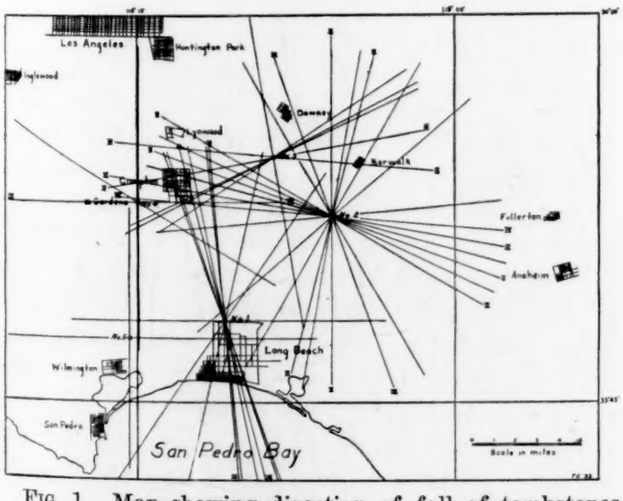

FIG. 1. Map showing direction of fall of tombstones in vicinity of Long Beach, California, March 10, 1933. No. 1, Sunnyside Cemetery; No. 2, Artesia Cemetery; No. 3, Old Downey Cemetery; No. 4, Woodlawn Cemetery; No. 5, Wilmington Cemetery. Roman numerals indicate number of monuments in same direction.

A marked convergence on the Compton area is at once apparent, with over 60 per cent. of the columns having fallen along lines radiating from Compton as a center. It was also noted by the writer in a reconnaissance examination that Compton was the most severely damaged in proportion to its size of any of the cities in the shaken zone. The inference, therefore, is that the epicenter of the earthquake was in and about the city of Compton.

The data from seismographs, however, indicate that the epicenter was on the sea floor a short distance off Newport Beach,[2] disagreeing entirely with the results of the writer. Yet there are inconsistencies with this conclusion other than that indicated by the overthrown columns. Balboa and Newport, built upon material not greatly different from that underlying Compton and Long Beach, and of more or less similar construction, were very much less severely damaged. Neither was there any semblance of a so-called tidal wave, which might have been expected with violent earthquake waves emerging on the sea floor, and this regardless of whether the movement along the fault was vertical or horizontal.

A possible explanation of the disagreement is the following. The first slip, of minor importance, may have occurred off Newport as indicated by the instrumental records. This slip in turn may have acted as a trigger to release accumulated stresses along the same or a near-by fault in the Compton region, the latter movement being much greater in magnitude than the former and causing the principal damage.

In view of the evidence offered, and the further corroboration by personal impressions of two distinct series of shocks, one following immediately upon the other, it is the opinion of the writer that the above explanation is a valid one and that the epicenter of the major shock was in or near Compton, California, at approximately 118 degrees, 13 minutes west longitude and 33 degrees, 54 minutes north latitude. The fault map of California, compiled by Bailey Willis and Harry O. Wood for the Seismological Society of America, shows a possible fault passing through this area approximately parallel with the Inglewood fault. It may have been movement on this fault, activated by an immediately preceding movement on the Inglewood fault off Newport Beach, that caused the damage in Compton and the surrounding area.

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THE VALUE OF AN ANIMAL BARRIER IN MALARIA CONTROL

MALARIOLOGISTS have for a number of years been debating the question of the value of an animal barrier

[2] Personal communication, Mr. H. O. Wood.

as a method of malaria control. One of the chief reasons for doubting the effectiveness of such a method has been the belief that *Anopheles* mosquitoes have definite blood-meal preferences. The anophelines which are effective carriers of malaria have usually seemed to have a distinct preference for human blood. Poor carriers have appeared to prefer animal blood. Precipitin tests have lent weight to this belief.

During the first four months of 1933, the staff engaged in malaria investigations[1] in the Philippine Islands made collections of adult *Anopheles* mosquitoes of the *funestus-minimus* subgroup in the municipality of Aritao in Nueva Vizcaya. The population of the area in which the collections were made was about 800. In the Philippines, as has previously been reported,[2] these mosquitoes can rarely be found inside or under houses. They are, as a rule, seen only out-of-doors, in natural resting places, such as undercut stream banks, where daytime catches can easily be made. Recently, collections of these mosquitoes were made at night, while the insects were feeding on carabaos.

The last catch dissected up to the present time numbered 705 mosquitoes. Of these, 133 were caught along stream banks by day, and 572 on carabaos at night. There were five infected mosquitoes among them. In one (*A. filipinae*) the gut only was positive; in one (*A. minimus v. flavirostris*) the glands only were postive; in one (*A. minimus v. flavirostris*) the glands were positive, but the stomach was not successfully dissected; in two (*A. minimus v. flavirostris*) both gut and glands were infected. One mosquito in which gut and glands were infected was caught along a stream bank. The other four infected insects were caught at night while feeding on carabaos.

Here, then, is strongly presumptive information to the effect that mosquitoes which had first taken blood from an infected human were attracted to carabaos for a subsequent feeding at a time when they were potentially dangerous to man. We have not been able to rule out absolutely the possibility of simian malaria or of carabao infections. Both are highly doubtful. Monkeys are very uncommon in Aritao, and the literature has no records of malaria infection in carabaos. This matter is being checked.

The possible usefulness of an animal barrier would seem to be indicated by these findings. But such barriers uncontrolled are of little use, because in the town of Aritao the blood smear index for malaria is about 30 per cent. A detailed report on this subject will be published eventually.

PAUL F. RUSSELL

BUREAU OF SCIENCE,
MANILA, P. I.

[1] The malaria investigations are jointly supported by the International Health Division of The Rockefeller Foundation and the Bureau of Science of the Insular Government of the Philippines.

[2] P. F. Russell, *Philippine Journal of Science*, 46: 639–649, 1931; and P. F. Russell, *Proceedings* of the Entomological Society of Washington, 34: 129–138, 1932.

"MAGMATISM"

THERE seems to be no adequate term for expressing the phenomena attending the primary placement of igneous material both within the earth's crust and upon its surface. In most text-books, the word "vulcanism" (or "volcanism") is made to answer for igneous processes, whether they are deep-seated or at the surface. This term seems inappropriate, since the idea implied applies particularly to volcanoes. The correlative words "volcanic" and "plutonic" are sometimes used to express the place or mode of occurrence of igneous rocks, according to whether they be extrusive or intrusive. Is it any more appropriate to use the word vulcanism than plutonism, for general igneous activities? The one might well be used for subsurface igneous processes; the other, for supersurface processes.

The writer has felt the need of a single term which might do for all igneous processes—to be used in much the same way as vulcanism is now used. For this purpose, he suggests the word "magmatism." The idea of this word is to represent the collective phenomena of volcanoes and their dispositional processes; dikes, laccoliths, batholiths, etc., in respect to the way they were formed—any and all movement of magma and its subsequent primary disposal as solidified crustal material. The old terms "vulcanism" and "plutonism" then could be used if desired, to distinguish the two types of magmatism.

R. W. ELLIS

UNIVERSITY OF NEW MEXICO

THE REVERSAL OF THE SODIUM LINE, "D," IN FIREWORKS

SOME years ago the writer noticed, at a glass factory in West Virginia, the reversal of the sodium line, "D," and published a note thereon in SCIENCE. Now we are able to supplement this occurrence in the rather unusual setting of fireworks. It happened at the recent "Fourth," at the beautiful grounds of the Kirtland Country Club, near Mentor, Ohio. The exhibits, while not so extensive or elaborate as those at the Washington inaugurals or at Coney Island, were unique and beautiful. Some of them were of a type new to me; and several gave spectra largely for the sodium compounds. I was using my pocket direct-vision, made by Franz Schmidt & Haensen, of Berlin, Germany. On three occasions, the bright sodium line changed suddenly from the bright form to the dark reversal. I was confirmed in my observation by a friend who sat near me, who saw it all clearly, both the bright and the dark line. The occurrence is un-

usual in my experience in that the very small and short volume of vapors in the fireworks could do what it did. The fireworks in question were of the large spinning-wheel type, and also of the fountain and rosette types, where the flames were massed in a space of some foot or more in diameter.

The writer would call the attention of those interested to this unusual occurrence and would invite correspondence thereon.

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SPECIAL CORRESPONDENCE

GEOLOGIC RESEARCH WORK NEAR RED LODGE, MONTANA

THE program of cooperative research work in geology, described by the writers in the issues of SCIENCE for August 1 and December 21, 1930, has already led to highly interesting scientific results and promises disclosures of an even more fundamental character. Indeed, so much is this the case that a brief note as to the status of the project and a historical sketch of its development are believed to be warranted at the present time.

In the field of paleontology, one of the most important discoveries which has been made is that of the Lower Devonian ostracoderm and arthrodiran fauna which was discovered at Beartooth Butte, Wyoming, in 1931 by a party consisting of Professors R. T. Chamberlin, W. H. Bucher, Erling Dorf and E. L. Perry, and Richard F. Miller—the first of the fossils being found by Dr. Perry. The collections obtained in 1931 were described in a paper by William L. Bryant, director of the Park Museum, Providence, published in the proceedings of the American Philosophical Society. Additional collections obtained in 1932 by a Princeton Scott Fund Expedition, led by Professor Dorf, are also being studied by Director Bryant and were described in part in a paper read before the last annual meeting of the American Philosophical Society. This fish fauna is remarkable both for the number, variety and perfection of the primitive fish remains comprising it, and because it contains forms closely comparable to many of those which have been obtained from the famous localities of northwest Europe and Spitzbergen. A highly unusual feature of the Beartooth Butte locality is the occurrence of beautifully preserved Lower Devonian fossil land plants in direct association with the fossil fishes—these plants having been studied and described by Professor Dorf in a paper presented before the Paleontological Society in December, 1932. Further collecting at this locality during the coming summer and in 1934 is contemplated by Professor Dorf. Other important paleontological results include the demonstration, according to Dr. C. E. Resser, of the fact that the Cambrian fossil collections from the Red Lodge area prove an interdigitation of northern and southern Rocky Mountain Cambrian faunas, which should aid materially in correctly determining the correlation of the Cambrian formations of the West. The presence of upper Ozarkian and lower Canadian formations in the area is also suggested by tentative fossil determinations made by Dr. E. O. Ulrich, of the National Museum, and Dr. Rudolf Ruedemann, of the New York State Museum. Collections of foraminiferal fossils obtained from the Jurassic Sundance formation of the Big Horn Basin have been studied and described by Professor J. R. Sandidge in a recent issue of the *American Naturalist* and it has been suggested by workers on the Pacific Coast that this work may aid in demonstrating the Jurassic age of Pacific Coast formations hitherto regarded as of Lower Cretaceous age. A study of the fossiliferous Miocene deposits south of Livingston will be made by Professor Sinclair and Dr. Jepsen this summer, with the assistance of V. C. Miller and Dr. E. C. Marshall, of Livingston.

Studies in petrology and economic geology have been carried on under the direction of Professors Edward Sampson and A. F. Buddington. An outstanding development of the three years' work has been the accumulation of evidence that the Stillwater igneous complex in the northwestern part of the Beartooth uplift is a strongly differentiated noritic sheet of Precambrian age with a stratiform arrangement of facies extraordinarily similar to those in the Bushveld complex of Africa, a fact first recognized by Professor Sampson. The differentiation of the sheet as a whole has been studied by J. W. Peoples, the chromite-bearing horizons by Professor Sampson and copper-nickel sulfide mineralization and the contact metamorphism at the base of the sheet by Arthur L. Howland. One or more bands with a little disseminated sulfide carrying slight amounts of platinum have been defined within the complex. A strongly metamorphosed zone of banded iron formation has been found in the country rock at the base of the complex and also about thirty-five miles to the southeast on Rock Creek, where it, together with masses of ultrabasic rocks and associated chromite deposits, are being studied by Kenneth P. Wilson. The composition and mechanics of intrusion of the Tertiary

porphyries have been studied at three different localities by John T. Rouse, Kenneth P. Wilson and John S. Vhay, respectively.

In physiography, the work has been concentrated on the determination of the number and interrelationship of such peneplain and pediment surfaces as may be present. A simultaneous study is also being made of the time relationship of these erosion surfaces to the sedimentary deposits occurring within the Big Horn Basin, the Yellowstone Park and the valley of the Yellowstone River north of Gardiner. Attack upon the physiographic-stratigraphic problems thus involved is being led by Professors N. M. Fenneman, R. M. Field and D. W. Johnson. When work along these lines progresses to a point where precise dating of the stratigraphic, physiographic and diastrophic features of the region is to be attempted, further work will have to be done on the several remarkable vertebrate faunas which have already been found in the Paleocene, Eocene and Oligocene sediments of the Big Horn and Wind River regions by Princeton Scott Fund Expeditions under Professor Sinclair and Dr. Jepsen, or by their predecessors from other institutions.

Geological and geophysical study of the features of the Red Lodge region, which has been directed and led by Professors R. T. Chamberlin, W. H. Bucher and W. T. Thom, Jr., has demonstrated that the region is characterized by certain types of deformational features, systematically arranged—the morphology of the features and the manner of their arrangement affording highly significant information as to the origin and general structural characteristics of the various Cordilleran mountain uplifts—thus yielding important clues as to the nature of the mountain-building process. In July, 1932, Professors Chamberlin, Bucher and Thom selected a series of points between Boxelder, South Dakota, and Cody, Wyoming, at which a field party of the U. S. Coast and Geodetic Survey subsequently made pendulum observations, thus affording a combined geologic and gravity profile across the Black Hills, the Powder River Basin, Bighorn Mountains and Big Horn Basin. Formation samples, for specific gravity determinations, were obtained by this geological party at the time the station selections were made, and porosity and specific gravity determinations for these samples have since been made by Mr. Claude Langton, of the University of Chicago Department of Geology, under Professor Chamberlin's supervision. Through the cooperation of the U. S. Coast and Geodetic Survey, Professor Chamberlin is now preparing a reanalysis of the gravitational data obtained last summer, a study which promises to have a direct and very important bearing upon the whole problem of isostatic compensation, adjustment and uplift, and which in turn will prospectively profoundly affect scientific opinion as to the nature and manner of operation of the orogenic process. Further structural and geophysical work in the Red Lodge region is planned by Professors Chamberlin, Bucher and Thom for the coming summer, and a grant of funds to support this structural and geophysical work has recently been voted by the Geological Society of America. Particular emphasis will be placed this year both upon the continuation of the physiographic-stratigraphic-structural (and geophysical) attack upon the problems of mountain origin and evolution, and upon field conferences between participants in the Red Lodge project and the foreign and American members of the International Geological Congress party which will visit the Red Lodge area in August.

In conclusion, a few words as to the history of the Red Lodge project is believed to be in order, because of its past results and because of its prospective future accomplishments. The idea of carrying out such a cooperative undertaking in the cause of geologic science originated with the senior writer in 1927, and was cordially and most helpfully concurred in, not only by the members of the Princeton Department of Geology and University Administration, but by many who were members of other universities or research institutions, as was indicated in the article published in SCIENCE, August 1, 1930. The enterprise has been conceived and carried forward as a voluntary association of individuals and institutions sharing a common interest in the effective advancement of geologic science and education. The initiation of the project was made financially possible in the first place by a cooperative arrangement between Princeton University and the Northern Pacific Railway negotiated through the Council of the International Summer School of Geology and Natural Resources, of Princeton University. Funds allocated by Princeton University and by the Princeton Department of Geology have been and continue to be the primary basis for the financing of the geologic research work in the Red Lodge region,—except that the structural and geophysical studies which will be conducted during the coming year will be financed as a project of the Geological Society of America on funds recently voted by that society. Due to the interest of participating students and to the enthusiasm and cordial interest of the collaborating members of other institutions, many of whom have personally contributed their own research expenses, the combined total of funds, thus afforded, has again been doubled through cooperative arrangements made by the writers with various government agencies—especially by arrangements made with and through the Montana Bureau of Mines and Geology.

The planning of the comprehensive program of physiographic-stratigraphic-structural researches now being carried forward in the Red Lodge region is being led by a volunteer committee consisting of Professors W. H. Bucher, R. T. Chamberlin, N. M. Fenneman, D. W. Johnson and the writers, W. T. Thom also serving as executive secretary responsible for the administration of the project.

W. T. THOM, JR.
R. M. FIELD

PRINCETON UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

VOICE TRANSMISSION ON A BEAM OF LIGHT

DURING the past months there have appeared several popular articles on the transmission of speech and music over a beam of light. These papers did not give the details. It is presumed that neon tubes and photoelectric cells were used.

Recently the author has set up a demonstration experiment using an ordinary direct current arc lamp and a photronic cell, or a photoelectric cell. This experiment worked so well it is thought that a somewhat detailed description might be of general interest.

This experiment was one of Indiana University's demonstrations at the State Fair. The operators say the experiment was the one demonstration which did not fail them during the week.

The set-up of the apparatus is shown in the diagram, Fig. 1. In this diagram the microphone, M, is

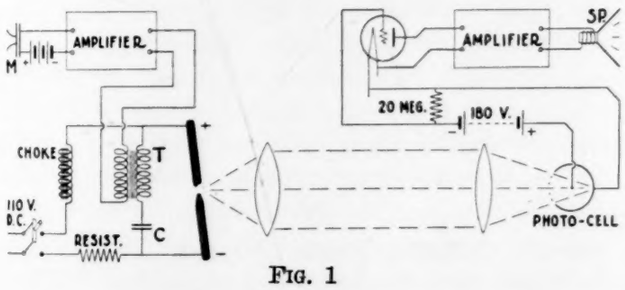

FIG. 1

connected to a two-stage microphone amplifier. The amplifier is connected to the transformer, T, which is an ordinary low impedance output transformer such as is used in connecting a tube to a dynamic speaker. The transformer, T, is connected across the terminals of the arc lamp through a four microfarad condenser, C. A large choke coil is placed in the D. C. supply line. This choke coil prevents the voice frequency being absorbed by the power line.

The diagram shows the receiving photoelectric cell connected to a resistance coupled amplifier. There should be two stages of resistance amplification and then two or three stages of transformer coupled amplification. The amplifier is then connected to a loud speaker.

It will be apparent that the exact connections will depend upon the amplifiers and speaker available.

The arc used was an old-fashioned arc projection lantern. This was focused so as to give a parallel beam of light. The parallel beam of light was focused on the light cell by means of a large reading glass.

Instead of the photoelectric cell a Weston photronic cell can be used. The photronic cell gives practically the same results with a stage or two less amplification in the amplifier. In the figure the photronic cell should be connected directly to the amplifier.

In the place of the microphone and the microphone battery a pick-up unit can be substituted and music from an ordinary record can be transmitted.

The connections of the arc lamp are the connections for a speaking arc. If the arc is working well one should hear the arc "talk" in a quiet room.

It is found that hard carbons give better results than the usual soft-cored carbons.

This set-up makes a striking experiment in a large darkened room where the length of the parallel beam is long, especially if there is enough dust in the air to make the path of the beam visible. Any object interposed in the beam causes the music to cease.

The early experiments involved in the above demonstration are:

Alexander Graham Bell[1] transmitted sound over a light beam from a mirror fastened to a membrane which was stretched over the end of a tube. By speaking into the tube the membrane was caused to vibrate. Then the light was reflected to a selenium cell. The variation of the light caused a variation of the resistance of the cell and this caused a reproduction of the sound in a receiving telephone.

Some thirty years ago it was found that an ordinary arc light could be made to talk if a microphone was connected properly across the arc. It seems that Bell and Hays in America and Simon in Germany discovered the speaking arc independently in 1897.

G. G. Blake[2] used an arc lamp and head phone.

R. R. RAMSEY

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A UNIVERSAL STAGE FOR OPAQUE OBJECTS

THE difficulties involved in manipulating small opaque objects under the microscope have led to the

[1] *Am. Jour. Sci.*, p. 305, Series 3, Vol. 20, 1880.
[2] Exp. Wireless, p. 561, 2, 1925.

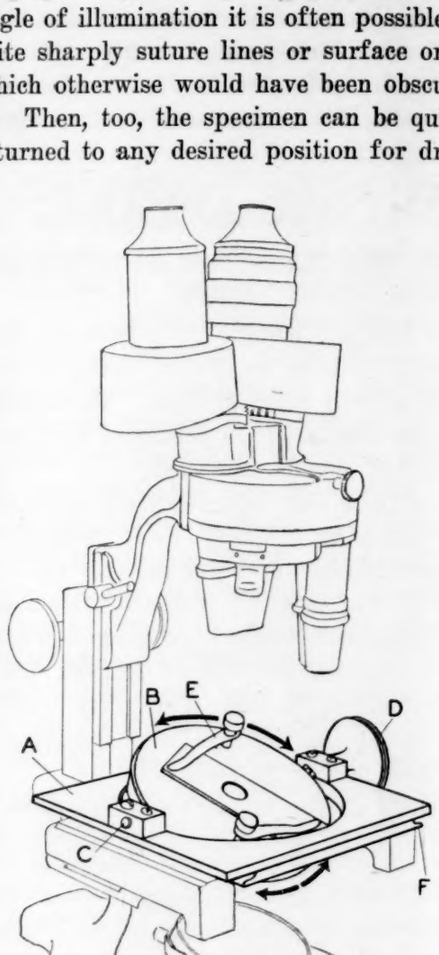
development of various devices and techniques for this purpose. This is especially true in the study of micro-fossils, where the number of specimens handled is often large. The means of obtaining different orientations vary all the way from successively gluing the specimen in different positions on the slide to complicated ball-and-socket devices. The former method often results in broken or lost specimens, while most of the mechanical devices are limited in range of movement or control.

Having these difficulties in mind I designed and built a stage which solves most of the problems encountered in this type of micro-manipulation. This stage rotates, and at the same time the axis of rotation may be tilted at any angle up to 90°, in a plane perpendicular to that of the objectives. This allows the specimen to be viewed from all sides (except that applied to the slide), at any given angle. The effect is to combine universal movement with a high degree of control.

In the accompanying figure the stage is shown in place on a binocular microscope. It consists essentially of a square stage base (A), which replaces the glass stage of the microscope, and a tilting, revolving stage (B), which is supported by the stage base. The stage proper consists of an upper and a lower disk, the upper rotating about an axis fixed in the lower. The lower disk is attached to the stage base by means of the offset shaft (C). This shaft is rotated by the wheel (D), so that the stage as a whole revolves about an axis which passes just above the surface of the slide and lies in the plane of the objectives. The slide is held in place by clips (E).

The whole mechanism is easily attached to the microscope by means of flanges (F), which slide into the grooves provided for the regular glass stage. The front and rear of the stage are interchangeable, so that the wheel (D) may be placed on either the right or the left side. In either position the axis of rotation passes through the center of the field when the back of the stage base rests against the vertical supporting pillar of the microscope.

This stage is most useful in studying or drawing small opaque objects. By changing the orientation and angle of illumination it is often possible to bring out quite sharply suture lines or surface ornamentation which otherwise would have been obscure or invisible. Then, too, the specimen can be quickly and easily turned to any desired position for drawing or



measuring. This is especially convenient when making drawings of Foraminifera, where three views at right angles are usually desired. In fact, we have found the stage most useful wherever rapid controlled orientation has been an important factor.

BROOKS F. ELLIS

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SPECIAL ARTICLES

MAMMALIAN LIFE WITHOUT RED BLOOD CORPUSCLES

IN certain invertebrate animals hemoglobin occurs in solution in the circulating blood, where it functions not only to transport the oxygen but to maintain a colloidal osmotic pressure. In all vertebrates hemoglobin normally occurs only within red blood corpuscles, and other proteins have been developed in the plasma to furnish the necessary colloidal components. It has been widely assumed that, in the vertebrates, hemoglobin is incapable of performing its respiratory function when outside of the red blood corpuscles.

We have recently found this assumption to be incorrect, at least in so far as the chemical behavior of the hemoglobin itself is concerned. A "hemoglobin-Ringer" may be prepared, in which hemolyzed mammalian red blood cells have been added to ordinary

Ringer-Locke solution, giving a concentration of dissolved hemoglobin approximating that of the normal plasma proteins (5 to 7 per cent.). The red cells are taken from beef, cat, dog or human blood, twice washed with Ringer-Locke solution, and, after the last centrifugalization, hemolyzed by the addition of distilled water or by ether. For best results absolutely fresh blood must be used. Beef cells are best adapted for the work; they readily hemolyze when added to distilled water, and their potassium content approximates that of normal blood plasma. The final solution is made isotonic with normal blood. The stromata are removed by the centrifuge. The oxygen capacity of the solution when finally prepared is about half that of normal cat or dog blood.

This solution may be introduced into the bodies of cats or dogs through a cannula placed in the jugular vein, and the blood simultaneously removed through a carotid cannula. In this manner, by continuous bleeding, all but the last traces of the normal blood may be swept out of the body, and the concentration of the red blood corpuscles may be reduced to the vanishing point. By this method we have observed:

(1) After complete removal of the normal blood from cats or dogs under veronal anesthesia and replacement by hemoglobin-Ringer the hemoglobin in solution appears to be able to carry oxygen, and furnish base for the transport of carbon dioxide much as when enclosed within the red blood cells. The respiratory movements continue, usually increasing in rate as the experiment progresses. The heart beat remains strong. Reactions to such drugs as adrenalin occur as in the normal animal. Circulatory and respiratory reflexes persist Other reflex actions are present; the pupil of the eye, for instance, constricts upon illumination. The oxygen consumption continues with little or no change during and for up to two hours after the removal of the normal blood. A similar constancy in oxygen consumption has been observed in heart-lung preparations of the dog.

(2) The hemoglobin in solution exerts a colloidal osmotic pressure, which prevents the edema which follows perfusion with ordinary Ringer-Locke.

(3) The completeness of the removal of the red cells has been checked by histological examination. All but the last traces of cells are removed from the various tissues when hemoglobin-Ringer amounting to eight times the normal blood volume has been passed through the body. The bone marrow is readily swept clear. The spleen alone holds some red cells for a longer time.

(4) Blood volume may be directly determined by collection and measurement of all red cells removed from the body. The most dependable values are secured from previously splenectomized animals.

(5) After the removal of the normal blood under ether anesthesia the animals may regain consciousness and exhibit an essentially normal behavior for several hours. Our best experiments of this type have been with cats. They are able to walk, run, see and hear. They are able to jump to the floor from a considerable height, judge distances correctly and make their way about in a normal manner. All postural and equilibratory reflexes appear to be normal. When dropped upside down they land on their feet. Respiratory rates are, however, higher in these animals than normal. They show a marked tendency to sleep, but are easily aroused and may become quite active, for a brief period, only to lapse into sleep again rather suddenly.

(6) Such animals finally die, after five or six hours, not because the hemoglobin is unable to carry on its respiratory function, but because it leaves the blood stream with much greater ease than do the normal plasma proteins. It appears in urine and feces, and is in part removed by cells of the reticulo-endothelial system. Its concentration within the blood-vessels falls considerably, the blood volume appears to diminish and the animal dies from oxygen lack and respiratory failure.

We conclude from these experiments that the chief function of the vertebrate red blood corpuscles is to hold hemoglobin within membranes impermeable to it, so that it can not leave the blood stream. In other respects hemoglobin appears to be able to carry out its respiratory rôle in solution much as it does within the red cells, sustaining every vital function, even the more complicated activities of conscious life.

A full account of these experiments will appear shortly in the *Journal of Cellular and Comparative Physiology*.

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THE BEHAVIOR OF FROG EGGS IN AN ELECTRICAL FIELD

NUMEROUS investigations have been made of the cataphoretic properties of living cells, but until recently the most reliable data have concerned bacteria and blood corpuscles. The electrokinetic potential of these small cells has been found to be negative. The studies of Mr. Katsuma Dan, of this laboratory, have demonstrated that sea-urchin eggs also bear a negative charge.[1]

[1] K. Dan, *Anat. Rec.*, 51: 28, 1931. Extensive paper to appear shortly.

The behavior in an electrical field of the egg of the frog *Rana pipiens* reveals marked electrokinetic properties in this cell, which is enormously larger than the microscopic cells whose charge has been determined. Freshly stripped eggs were introduced into a trough 8 mm wide and 5 cm long, containing pond water, pH 6.8. A potential of 10 volts was applied by a $Zn–ZnSO_4$–agar system in which the agar bridges completely occupied the ends of the trough, so that the lines of current flow were parallel to the walls and floor of the chamber. The current intensity used was 1 milliampere.

When the current is passed, the egg within its jelly layers begins almost immediately to move toward the cathode, at the rate of about 10 microns per second. This occurs regardless of whether the animal or the vegetal pole of the egg faces the cathode. The egg migrates as far as possible within the jelly, often distending it at the cathodal end, and sometimes being flattened against this end by its pressure.

When dry eggs, *i.e.*, those with jelly unswollen, are introduced, or any eggs whose jelly is not too sticky, the whole egg, jelly and all, moves toward the cathode. This motion begins after the migration within the jelly, and, although it is irregular because of the fact that the egg lies on the bottom of the chamber, it has about the same or even a higher velocity. Observed values range from 8 to 19 microns per second. As the jelly moves, the egg appears eccentrically located within it, at the cathodal end. Because of the narrowness of the trough, the movement can not be ascribed to endosmotic current due to the charge upon the walls, for the currents in both directions impinge upon the egg. The fact that the jelly too migrates to the cathode precludes the possibility that electroosmosis through the jelly is the cause of the movement of the egg within it. The truly "cataphoretic" nature of the migration can further be verified by using eggs whose jelly has been removed with KCN. Eggs so treated move toward the cathode very clearly, although they lie on the bottom of the chamber.

In all cases the jelly swells to many times its normal volume during the passage of the current. When dry eggs are introduced, the jelly does not swell uniformly, as it does when the eggs are simply placed in water. There occurs immediately a very rapid swelling at the anodal end, none at the cathodal. Since the egg has migrated during the course of the swelling, it appears pressed against the original thin layers at the cathodal end, backed at the anodal end by a great swollen mass of jelly. Within the inner jelly layer at the anodal end, large sacs or vacuoles are seen to form, evidently by the pressure of the water moving anodally.

Cataphoretic movement of cytoplasmic granules within plant cells has been observed by Hardy[2] and others. Hardy clearly demonstrated movement toward the cathode. A similar movement can be seen within the frog egg. When the current is passed through water in which the egg lies, there appears, after a short time, a narrow clear margin beneath the membrane at the anodal end, and this clear space widens until it occupies about one tenth the diameter of the egg. The appearance is the same whether the animal or vegetal pole or the equator of the egg faces the anode. The contents of this clear space are easily distinguishable from the yellowish yolk. If now the direction of the field is reversed, the granules move back through the clear space, obliterating it. Then a similar space is formed at the new anode. This behavior on reversal demonstrates that the phenomenon is a true movement of granules toward the cathode, and not a breakdown of colored material at the anode.

These observations, repeated many times on eggs from different frogs, are purely qualitative, since the condition of free suspension demanded for cataphoresis measurements is not satisfied. They do, however, indicate a positive charge upon the egg as a whole and upon the internal granules, a charge whose magnitude may be exactly determined in later studies.

D. MAZIA

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BABCOCK, MARJORIE E. *A Comparison of Delinquent and Non-delinquent Boys by Objective Measures of Personality.* Pp. 73. Author, University of Hawaii.

BEST, C. H. and N. B. TAYLOR. *The Human Body and Its Functions.* Pp. xiii + 417. 298 figures. Holt. $3.75.

BRAGG, SIR WILLIAM. *The Universe of Light.* Pp. x + 282. 26 plates. 110 figures. Macmillan. $3.50.

CHERRY, F. H. *Descriptive Geometry: An Introduction to Engineering Graphics.* Pp. xi + 127. 75 figures. Macmillan. $2.00.

COSGROVE, H. S. and C. B. *The Swarts Ruin: Report of the Mimbres Valley Expedition, Seasons of 1924–1927.* Pp. xxiii + 178. 239 plates. 17 figures. Peabody Museum of American Archaeology and Ethnology, Harvard University.

EDWARDS, HIRAM W. *Analytic and Vector Mechanics.* Pp. x + 428. 160 figures. McGraw-Hill. $4.00.

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[2] W. B. Hardy, *Jour. Phys.*, 47: 108, 1913. Older literature in Heilbrunn, "Colloid Chemistry of Protoplasm," 1928.